Considering the discrete aspects of electrical power systems in AC Optimal Power Flow problems (AC-OPF) with Mathematical Program with Equilibrium Constraints (MPEC).

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Résumé

In this presentation, we'll give an overview of the work done on the AC Optimal Power Flow problems as part of the iTesla project, a European R&D project, which consists in developing and validating an open interoperable toolbox able to support the future operation of the Pan-European grid. The Optimal Power Flow problems consist in determining, on the basis of electric energy consumption forecasts, an operating plan of the power system which will satisfy transmission security constraints while minimizing losses.
In this paper, we refer to the AC formulation of these problems that simultaneously optimizes active power (P) and reactive power (Q). This formulation allows the computation of exact electrical losses in the power system network but introduce nonlinear terms. In the literature, several methods were successfully applied on a large number of instances, which helps us to focus on a more complex variant of the standard AC-OPF where production units are enabled to be switched OFF and ON, in order to allow Transmission System Operators (TSOs) relocating the electricity production to minimize losses among lines. This functionality brings the problem into the mixed discrete/continuous optimization field.

Considering the fact that unfeasibility detection already was an issue, we proposed a Mathematical Program with Equilibrium Constraints (MPEC) model to maintain the use of a continuous optimization solving approach. An MPEC formulation was also evaluated on another variant of the standard AC-OPF where Phase-Shifting Transformers (PST) are allowed to be reconfigured. In this case, PST taps have no setpoint values and therefore have to be determined. Moreover, PST taps follow configuration laws that evolve discretely.
Numerical results obtained with AMPL and KNITRO 8.1.1 show the efficiency of the MPEC formulation for solving discrete AC-OPF. Instances handled are composed of more than one thousand nodes and two thousand branches. There are more than ten unit groups that can be switch ON and OFF and several PSTs with a lot of taps.

Mots-Clés: AC Optimal Power Flow, Mathematical Program with Equilibrium Constraints, MPEC, MINLP, Electricity networks

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